3.6 Structural BMP Maintenance and Inspection Guidelines

3.6.1 Introduction

The purpose of this section is to provide owners of structural BMPs with guidelines to help maintain the BMPs. It is often the case that owners do not fully understand what the BMP on their property is designed to do, much less how to properly maintain it. With different and more complex stormwater BMPs being introduced, it is even more crucial that owners know about the maintenance required for a particular BMP before they decide on one to implement. For owners to appreciate the need for maintenance, it is important that owners are aware that BMPs provide value to the quality of our surface waters and in many cases can be an amenity to their property.

Periodic inspections and maintenance are key factors in preserving the functionality of structural stormwater BMPs. Stormwater BMPs are not self maintaining systems, and over time the efficiency of structural BMPs to remove pollutants will diminish. Trapped sediments and other pollutants can potentially reduce the volume capacity of the BMPs, decrease filtration rates for filtering BMPs, and damage plantings used for treatment. The following guidelines are provided for the benefit of owners of structural BMPs to help ensure that the BMP will continue to meet the objectives they were designed for.

Besides inspecting and maintaining components in which a BMP's water quality functionality is to be sustained, attention must also be paid to the structural components to sustain its hydraulic functionality as well. Minimizing the risk of hydraulic malfunction (potentially leading to structural failure) is essential, especially for larger impondment structures such as wet detention ponds, since the majority of the stormwater BMPs in Greensboro are located in urbanized settings, where structural failure may jeopardize downstream life and property.

Maintenance is also important to prevent the decline in the appearance of the BMP. Unhealthy conditions (such as noxious vegetation, stagnant water, etc.) may occur within and around the BMP, which may affect the aesthetics and economic value of the surrounding property.

3.6.2 BMP Maintenance Requirements

The City's water-supply watershed (Ch 30) ordinance and the 1999 stormwater management (Ch 27) ordinance require that BMPs which are constructed to meet these requirements must be maintained by the property owner or owners' association. The BMPs must be maintained to continue to function to meet the regulations it was designed for. The City has the authority to inspect these BMPs periodically and require the BMP owner to perform maintenance activities, when necessary.

The City, as required by the State, will conduct periodic inspections of structural BMPs implemented for water-supply watershed protection. The City will advise the owner of recommended and required maintenance actions needed to maintain BMP functionality.

The design engineer and developer should be responsible for providing BMP owners with inspection and maintenance guidelines and educating them on it.

3.6.3 General Maintenance Guidelines

Dam Safety *(This section is applicable to all above ground BMPs that utilize a dam to*

permanently or temporarily retain or detain water).

Preserving the structural integrity of the dam of a pond BMP is important in protecting downstream life and property. There are at least four aspects of the dam that require specific attention: (1) *assessment of hazard potential* due to changes in downstream development; (2) *seepage*; (3) *dam material problems*; and (4) *vegetation growth* on the dam embankments

Assessment of Hazard Potential

Before any dam is constructed, the design engineer is responsible for notifying the NC State Dam Safety Office of the proposed dam. If the dam falls under State Dam Safety jurisdiction, the dam must be constructed, maintained and operated according to their design and construction guidelines. Even if the dam does not fall under the NC Dam Safety Office's jurisdiction, the dam should be designed and constructed in accordance with current good engineering practice. The City has requirements concerning the maintenance of dams associated with required BMPs.

As new development occurs downstream of the BMP, the chance of significant property damage or danger to human life may increase if catastrophic failure of the dam occurs. Although the dam may be initially exempt from regulation by the State, the owner is responsible for reporting to the State Dam Safety Office downstream development that may affect the hazard classification of the dam.

Seepage

The downstream side of the dam should be inspected regularly for evidence of significant seepage. Seepage can emerge anywhere below the normal pool elevation, including the downstream slope of earth dams, areas beyond the toe of the dam, and around the spillway or pond outlet conduit. Indications of significant seepage include areas where the soil is saturated or where there is a flowing "spring" or leak. If "sinkholes" in the dam embankment are noticed, or if constant flowing water is noticed on the downstream side of the dam, then seepage has become excessive and professional engineering advice should be sought immediately to avert a major structural problem or a catastrophic failure of the dam.

Dam Material Problems

For earth dams, pronounced cracks on the embankment surface indicate the first stages of potential dam failure. Transverse cracks (running perpendicular to the embankment face) generally indicating differential settlement of the dam, can provide pathways for excessive seepage. Longitudinal cracks (running parallel to the embankment face) may be due to inadequate compaction of the dam during construction or shrinkage of the clay (desiccation) in the top of the embankment during prolonged dry conditions. These cracks may eventually lead to slope failure such as sliding or sloughing.

For reinforced concrete dams, the concrete should be checked for pronounced cracking, leakage from the joints, and displacement (noticeable leaning or bulging). Also, excessive seepage, leakage, or springs just downstream of the concrete dam could be indicative of potential seepage-related "piping" problems under the dam.

If such problems or other structural problems are observed, professional engineering advice should be sought.

Vegetative Growth

Trees and other woody vegetation are not permitted on the top slopes or dam embankments. Large root systems from woody vegetation can weaken the dam structure and provide seepage pathways. Thick vegetative cover can

also provide a haven for burrowing animals such as the groundhog. These animals can create a network of burrows in the dam embankments that can significantly weaken the dam, by creating seepage paths, which may eventually lead to dam failure. Mowing of the dam embankments should occur, at a minimum, once every 6 months to prevent woody vegetation growth and cover for burrowing animals.

Reduction of Pollutants Entering BMPs

Stormwater BMPs are not 100% efficient in removing pollutants; therefore, when the amount of pollutants into the BMP is higher, the amount of pollutants discharged from the BMP will be higher. Also, increased amounts of pollutants to the BMP will increase the maintenance required to keep the BMP functioning properly. Maintenance to BMPs can be very expensive.

Pollution prevention activities

To assist the stormwater pond in stormwater quality enhancement, every effort should be made to reduce the pollutant load entering the pond system. Pollution prevention BMPs described in Section 3 of this manual should be implemented along with the following efforts:

- ⇨ Outside trash dumpsters should be kept covered, and the area around the dumpster should be kept neat and clean.
- ⇨ Chemicals, petroleum products and other pollution sources (such as machinery) should be stored in a covered area away from possible stormwater contact. Spent chemicals are to be properly disposed or recycled.
- ⇨ Fertilizers and pesticides should be used conservatively on the property grounds. Excessive amounts of these chemicals can be washed away with stormwater runoff increasing the nutrient load to the pond.
- ⇨ Chemicals such as copper sulfate used to inhibit algae growth in the water quality pond degrade water quality. Since the pond's main function is to enhance water quality, these chemicals should not be used. Rather, reducing the amount of fertilizer application and ensuring that the pond outlets are properly functioning so the pool is flushed periodically will help to deter algae growth.
- ⇨ Trash and vegetative floatables (grass clippings, leaves, limbs, etc.) should be cleaned from the pond surface and surroundings periodically to promote a healthy, aesthetically pleasing environment, and to prevent blockage of the pond outlets. Studies have shown that people are less likely to litter ponds that are aesthetically pleasing and support wildlife.

Stabilization of BMP drainage area

The area draining to the BMP pond should remain stabilized to prevent excessive sediment from entering the BMP facility. When the bare soil is directly exposed to precipitation the sediment concentration in runoff is much higher than for soil that is stabilized. A stabilized area is covered by impervious surfaces (pavement, buildings), grass cover, landscaped cover (mulch, pine straw), etc.

For filtration practices such as sand filtration facilities and bioretention, maintaining a stabilized drainage area is especially important. Eroded sediment can quickly "seal" the filtration bed, drastically decreasing its filtration capacity.

3.6.4 Grass Swales, Filter Strips

Grass Cover

After initial seeding, the grass should be watered, as needed.

The grass should be mowed periodically (usually when mowing the rest of the property). To maintain the filtering capability of the grass, it should not be mowed to close to the ground (three to four inches minimum).

The ground should be inspected to make sure there is dense growth on all portions of the control device. Bare spots or areas where there is sparse grass cover should be reseeded. It may be necessary to use a temporary erosion resistant matting or to use sod to repair these areas.

As always for grassed areas, fertilizers and pesticides should not be over-applied. Refer to product directions for correct application quantity.

The grass used should be erosion resistant and can tolerate frequent inundation (standing water). Tall fescue is an appropriate choice.

Erosion Problems

The inlet and outlet areas, side slopes (swales), and the rest of the conveyance area should be inspected for erosion problems.

Where water discharges from a pipe and where the stormwater runs off impervious area onto pervious area, there may be erosion problems. The BMP should have riprap protection at the end of pipes and a gravel trench at the edge of impervious areas to help prevent erosion. These devices should be inspected to ensure they are functioning properly. If erosion is noticed in within the rip rap pad or along the edges of the pad, more rock may be needed or it may have been improperly placed (no geotextile liner or improper placement of liner, rip rap not well graded, etc.) If the rock or gravel is displaced downstream, a larger size rock or gravel should be used.

Rill erosion (small channels or gulleys in the ground) is a common problem found in these control devices where the water runoff is naturally trying to channelize. Rill erosion can be repaired by filling in the rills with suitable (clayey) soils and reseeding. It may be necessary to use a temporary erosion resistant matting or to use sod to repair these areas.

Sediment Build-up

Because these BMPs are designed to slow stormwater flows down, sedimentation of coarse particles will occur. Over time the sediment level within the bottom of the swale or filter strip will increase, especially at the upstream area. Sediment will need to be removed periodically (once build-up exceeds one to two inches) from the BMP.

3.6.5 Dry Detention Basins, Wet Detention Ponds, Stormwater Wetlands

The following items should be inspected/maintained on a quarterly basis. These items are in addition to any NC Dam Safety requirements for dams regulated by that agency.

Buffer Vegetation

Strong rooted grasses that have a high tolerance for erosion should be planted on embankments around the pond. Good grass cover should be maintained around the pond perimeter to prevent excessive sediment from entering the pond. The following should be used as guidelines for maintaining buffer vegetation.

- ⇨ To sustain the structural integrity of the dam, no trees or woody vegetation should be allowed on the dam embankments or top of dam. These areas should be mowed on a quarterly basis.
- ⇨ To preserve the hydraulic capacity of the pond system and to prevent runoff from backing up, inlet and outlet areas should be kept clear of heavy vegetation.
- ⇨ To provide easy access to the pond, the maintenance access around the pond should be free of trees and mowed on a periodic basis.
- ⇨ Trees and brush, if desired, are acceptable on pond embankments other than the dam.

Erosion Problems

Unsuitable fill material, inadequate compaction, and/or poor stabilization of earth structures can result in accelerated erosion where high runoff velocities exist. High velocities usually occur on steep pond embankments, at pond inlet and outlet discharge areas, and where the water is constricted to channel flow. The entire pond area should be inspected quarterly for signs of erosion, paying special attention to the following areas:

Embankments
If pond embankments are not kept well vegetated with grasses, rill erosion (small channels formed in the embankment due to poor grass cover) may occur. Rill erosion can be repaired by filling the small channels with suitable soil, compacting, and seeding. It may be necessary to install temporary erosion control (such as hay bales) along heavily eroded areas to allow the repaired areas to stabilize. It is especially important to inspect for and immediately repair any erosion on the dam embankments.

Pipe Inlet and Outlet areas
Where erosion causes the undercutting of the downstream end of pipe, the undercut should be stabilized immediately to prevent the end pipe section from "breaking" off. Eroded areas should be filled with good compactable soil and covered with geotextile and riprap.

Open Channel Flow
Eroded areas should be seeded/sodded and protected with temporary velocity dissipation (such as excelsior matting, straw bales, etc.) If erosion continues, a more robust lining should be used.

Blockage of Outlets

Wet extended detention ponds are designed for the water to exit the pond through the low flow orifice(s), the principal spillway, and the emergency spillway. It is important to check all three outlets for blockage that would impair the pond's water quality and hydraulic functionality.

Low Flow Orifice(s)
Unless an inverted orifice is used, some type of trash guard is to be maintained over the low flow orifice(s) to prevent clogging. When the orifice becomes clogged the water level rises to the principal spillway elevation and the benefits associated with temporary storage and its gradual release are lost. To preserve

"extended detention" the low flow orifice should be inspected for blockage **twice a month and after large storms.**

Principal and Emergency Spillway

Principal and emergency spillways are designed to safely convey larger than one inch storms that produce runoff which exceed the water quality volume of the BMP. If these spillways are blocked so they do not operate at full capacity, the risk of dam overtopping or other uncontrolled releases may result. To ensure the hydraulic capacity of the spillways, the spillways should be inspected for blockage **twice a month and after large storms.**

If a riser/barrel is used for the principal spillway, a trash rack is to be maintained on the riser. Vegetative growth in the riser should be removed promptly so that the design capacity of the spillway is maintained. Also, the outlet area where the barrel projects from the fill should be clear of tree limbs, sediment accumulation, etc.

Sediment Accumulation

To preserve the BMP's pollutant removal capability, sediment must be removed in areas where the capacity of the design sediment storage volume has been exceeded.

Dry Detention Basin

The sedimentation in dry detention basins will generally not be as much as in wet detention ponds or stormwater wetlands. Sediment accumulation will be less noticeable in dry basins that are open and have a vegetated bottom and embankments. Dry detention basins that have extended detention (24 hours or greater), will have more sedimentation. Sediment should be removed when the detention storage capacity is reduced or when aesthetics is a concern.

Wet Detention Pond

The forebay helps to improve the removal efficiency of the pond system by trapping the majority of coarser suspended solids behind the baffle. When sediment deposition in the forebay exceeds the designed sediment storage capacity for the forebay, the forebay must be dredged. An indication of when the forebay sediment capacity is exceeded is when sediment bars are visible near the inlet discharge or when the sediment level at the inlet to the pond is less than one foot below the normal pool surface (the elevation of the pool is at the bottom of the low flow orifice). Typically, forebays will need to be dredged every 5 to 10 years.

Depth measurements relative to the normal surface elevation (bottom of water quality orifice) should be taken at several locations around the pond. The sediment is to be removed when the measured depth is less than the design permanent pool depth. If a forebay is used at the inlet area of the pond and is regularly dredged, the frequency of dredging the entire pond could be greatly reduced.

Wetland

The forebay helps to trap the majority of suspended solids to prevent the sediment from entering the wetland area and suffocating the plantings. When sediment deposition in the forebay exceeds its designed sediment storage capacity, the forebay must be dredged. It may be necessary to drain down the wetland to measure the depth of sediment deposited. It is projected that the wetland forebay will need dredging every 3 to 5 years.

Sediment accumulation should be monitored in the wetland area as well. A layer of peat will form in the wetland at a rate of 0.5 inches per year (Hammer 1997). When sediment deposition equals six inches or more the sediment should be removed. The wetland plantings that are destroyed during the cleanout are to be replaced.

Sediment from most sources is usually not hazardous or contaminated, however, it is very "soupy" and is difficult to manage. It is good idea to provide a storage area near the BMP to place sediment once it is dredged to allow it to dry. If desired, sediment may be land applied and seeded. If land applied on-site, it should be within the drainage area to the BMP so sediment that runs off can be recaptured.

Wetland Vegetation

It is likely that a portion of the initial plantings will not survive the first growing season due to factors such as the quality of the plantings, selection of plantings, variable water levels, lack of water, etc. Therefore, it will most likely be necessary for the owner to add additional plantings during the initial development stage of the wetland. Over the long term, drought or other factors may cause a portion of the wetland plantings to die off and need replacement.

Proper Water Balance

An important step to developing a successful wetland system is to ensure that the water balance in the wetland is appropriate to support plant life. The wetland must be able to sustain water and to provide a certain level of inundation after storm events. If the wetland is not sustaining an adequate water balance adjustments will be need to be made to the outflow rates. The slow release outlet should be equipped with a valve to control the water levels in the wetland.

It may be necessary to periodically irrigate the wetland if the wetland is unable to sustain a water level that is conducive to wetland plant growth.

3.6.6 Bioretention Areas

Paved Sweeping Program

A paved area sweeping program should be implemented for all properties that utilize bioretention BMPs. Sweeping paved areas on a periodic basis will help extend the life of the BMP by reducing the pollutant load and debris that enters it. Debris shall be swept away from the pretreatment component (filter strip, channel, or chamber).

Mowing/Landscaping Activities

Mowing/landscaping activities on the property should to be conducted in such a way to prevent lawn and plant clippings as well as eroded sediment from entering the bioretention cell. One way to prevent clippings from entering the cell is to use mulching mowers or bag and remove clippings, especially in areas that drain to the filter.

Minimum Inspection/Maintenance Requirements

The following inspection/maintenance activities should be conducted on a **quarterly** (i.e., 4 times per year) basis, unless noted otherwise.

Overall bioretention area

(a) Accumulated paper, trash, and debris should be removed from the bioretention area.

The bioretention area should remain clear of trash and debris to preserve the draw down rate and stormwater treatment function of the cell. The type of debris removed should be noted and their possible sources identified. Efforts should be made to reduce the amount of the debris entering the bioretention area.

(b) Observe the filtration performance of the cell (every six months at a minimum).

If the drawdown time of the filter bed is greater than the design drawdown time corrective maintenance is needed. Corrective maintenance to restore proper drawdown time and stormwater treatment performance of the filter bed includes:

1. Clean out the underdrain system.

2. Remove mulch and top few inches of planting soil and replace.

   The clogged material should be replaced with new material of the original specifications. Contaminated soil should be removed and disposed of at an approved site (landfill). Instead of replacing the top layer of planting soil, it may be possible to aerate or cultivate the first few inches to restore the draw down capacity of the cell.

3. If appropriate draw down time cannot be restored the owner will be required to remove and replace the filter bed and under drain system.

Pretreatment

(a) Inspect energy dissipators for proper functionality.

Energy dissipators (pea gravel diaphragm, riprap pads, check dams, etc) that are used to slow down and spread the runoff before it enters the bioretention cell should be inspected for proper functionality. Sediment build-up should be removed. Once the voids become substantially filled with sediment, the rock must be removed, cleaned (away from bioretention area) and placed back in its original location. Larger rock or other measures may be required if the rock is being carried away by high water flows.

(b) Inspect sedimentation/diversion chambers (if applicable) for sediment build-up and blockage.

The sedimentation/diversion chamber should be cleaned out when sediment levels exceed the design level (12 inches accumulation depth is to be used if no design level is given). The sludge should be removed and disposed of at an approved site (landfill). All inlets and outlets to the chamber should be inspected for blockage.

(c) Inspect filter strips and channels for bare areas, rill or channel erosion.

A robust grass cover for the pretreatment areas must be maintained. Bare areas and eroded areas should be seeded or sodded immediately.

Plantings

(a) Replace plantings that are dead, diseased, or otherwise have failed to establish.
If replacing plantings frequently, the planting soil may need to be tested. Make sure that the plantings used are to able withstand the bioretention environment (i.e. frequent inundation).

(b) Pruning and weeding the bioretention cell may be aesthetically desired.
Make sure that all loose vegetation is removed from the bioretention cell so as not to interfere with the functionality of the cell.

Mulch Layer

(a) Inspect the cell for proper mulch cover.
Mulch needs to be reapplied in areas where erosion has displaced the mulch (mulch just may need spreading out). It will be necessary to replace the mulch layer every year when the mulch decays. The thickness of mulch should be approximately 3 inches.

Planting soil

(a) Test the pH of the soil (annually)
To keep plantings healthy, the planting soil shall be tested once a year to determine if the pH is in the acceptable range. If the pH is low than lime should be applied; if the pH is high then iron sulfate can be used.

(b) Test the toxicity of the soil (as needed, approximately once every 5 years)
After a few years of service, the quantity of heavy metals and other pollutants that is collected by the cell may reach toxic levels impairing plant growth and the effectiveness of the cell. If the toxic levels are too high, the soil will need to be replaced.

Outlet

(a) Verify that there is discharge from the underdrain when water is ponded in the cell.
When the water level is above the filter bed, check the outlet area to ensure that the bioretention cell is functioning. If there is no discharge from the outlet, the system is nonfunctional and corrective maintenance is needed immediately to restore draw down.

(b) The overflow structure should be inspected to ensure it is not blocked with debris and is functioning properly.

(c) Inspect for and fix erosion problems at the outlet areas
The downstream areas from the outlets of the bioretention area should be checked to ensure there is no erosion. Eroded areas should be revegetated. An energy dissipator, if not already in place, may be needed if erosion continues to occur.

3.6.7 Sand Filtration Facilities

Paved Area Sweeping Program

A paved area sweeping program is recommended for all properties that utilize a sand filter. Sweeping paved areas on a periodic basis will help to extend the life of the filter by reducing the pollutant load and debris entering the filter. Sweeping should be done in such a manner as to prevent debris from entering inlets leading to the sand filter.

Mowing/Landscaping Activities

Mowing/landscaping activities on the property should be conducted in such a way to prevent lawn and plant clippings as well as eroded sediment from entering the filter facility. One way to prevent clippings from entering the facility is to use mulching mowers or to bag and remove clippings, especially in areas that drain to the filter.

Minimum Inspection/Maintenance Requirements

The following inspection/maintenance activities should be conducted on a **quarterly** (i.e., 4 times per year) basis, unless noted otherwise.

Overall Sand Filter Facility

(a) Accumulated paper, trash, and debris are removed from the filtration facility.
Large debris should be removed from each chamber within the sand filter facility to preserve the draw down rate and stormwater treatment function of the filter. Note the type debris is removed and identify possible sources. Efforts should be made to reduce the amount of the debris entering the filtration facility.

(b) Check to verify that there are no signs of cracking or deteriorating concrete (every 6 months at a minimum).
Check for signs of pronounced cracking in the concrete and other structural problems that may present a hazard to the public (especially underground filters that carry vehicle loading).

Sedimentation Chamber

(a) Check to verify that the perforated pipe or low flow orifice (if applicable) is clear of debris.
Some systems use low flow orifices or perforated pipes to slowly distribute water from the sedimentation chamber to the filtration chamber. To assure the capacity of the filter, these components are to be inspected quarterly and unclogged as necessary.

(b) Measure the sediment depth at several locations in the sedimentation chamber (every 6 months at a minimum)
The sedimentation chamber should be cleaned out when sediment levels exceed the design level (12 inches is to be used if no design level is given). The sludge should be disposed at an approved site (landfill). If the sedimentation chamber utilizes a submerged weir to trap floatables, any oil on the surface must be removed separately and recycled before the chamber is pumped.

Filtration Chamber

(a) Monitor the performance of the filter bed (every six months at a minimum).

If the draw down time of the filter bed is greater than twice the initial design drawdown time corrective maintenance is needed. Corrective maintenance to restore proper draw down time and stormwater treatment performance of the filter bed includes:

1. Clean out the under drain system.
2. Replace the top layer of the sand filter bed

Accumulated sediment on top of the sand bed and the top layer of discolored sand should be scraped off. The removed sand should be replaced with new sand of the original specifications. The sediment and contaminated sand should be disposed at an approved site (landfill).

If a filter fabric/screen is used on top of the sand layer, replace it with a new fabric/screen of the original specifications. If gravel is used on top of the filter fabric/screen, rinse the gravel well and reuse. The sediment rinsed from the gravel should be collected. The used filter/screen and collected sediment is to be disposed at the landfill. Before replacing the fabric/screen, be sure to check to see if the sand layer is contaminated.

3. If appropriate draw down time cannot be restored the owner will be required to remove and replace the filter bed and under drain system.

If the filter bed is not draining at all, the stagnated water must be released by the dewatering valve or pumped out before corrective maintenance can be done to the sand bed. If oil is present on the surface it should be removed separately and recycled.

Outlet Chamber/Outlets

(a) Check to verify that the outlet is discharging when water is present in the filtration chamber.
When the water level is above the filter bed, check the outlet area to ensure that the sand filter is functioning. If there is no discharge from the outlet, the system is nonfunctional and corrective maintenance is needed immediately to restore draw down.

(b) Check to verify that there is no erosion at the outlet areas.
The downstream areas from the outlets of the sand filter should be checked to ensure there is no erosion taking place. Eroded areas should be revegetated. A velocity dissipator, if not already in place, may be needed if erosion continues to occur.

3.6.8 Proprietary Stormwater Treatment Facilities

Consult with the manufacturer for proper inspection/maintenance specifications. Most manufacturers have prepared a detailed Operation and Maintenance manual and provide maintenance services. The City of Greensboro requires that the owner follow the maintenance requirements for these systems and provide documentation of all inspections and maintenance activities performed.